MS210
Simple SPI Recorder IC With Voice Changer Datasheet

MShine Technologies Corporation

HEAD QUARTER

Floor 2, No 1008, Chung-Hsing Rd Sec 4,
Chu-Tung, Hsinchu, 31061, Taiwan
TEL: +886-3-5833899
FAX: +886-3-5830858

ShenZhen/China Office:

TEL: +86-755-26642629
FAX:+86-755-86210681

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Features

- Recording Microphone input to connected SPI flash memory, very low cost.
- All data kept when power is OFF.
- 1 MBIT SPI flash may record 30 seconds of speech with 8 KHz sample rate.
- Supports up to 64 MBIT, which is about 35 minutes with 8 KHz sample rate.
- Play the recorded sound directly from the SPI flash memory to 8 ohm speaker.
- Sample-rate is adjusted by external resistor.[1]
- **Play pre-recorded voice before or after the later recorded voice. (PAD Option). Pre-recorded voice will not be erased.**
- Pre-recorded voice can be played with different sample rate with simple external components.
- Built-in 1280 bytes of RAM for FIFO while erasing flash memory.
- Operating from 2.3 ~ 4.5V.
- Sleep power consumption < 10 uA with flash memory.
- Key button inputs
  - PLAY, edge trigger or level- hold to play the recorded sound.
  - REC, edge trigger or level-hold to record the voice.
  - RECL can interrupt PLAL operation, suitable for card applications.
- BEEP prompt for recording.
- Voice-Changer Capability when playing recorded voices:
  - Robot
  - Pitch shift
- Playing/Recording LED Driving
- Playing 3 Hz LED output.
- Act as band-limited amplifier if TEST and SPIMISO connect to GND, and PLAE connect to LEDBZ.

[1] For recording applications, sample rate is limited by 2560/[Flash sector-erase-time]. Recording sample will missing if recording-sample rate is greater than 2560/[Flash sector-erase-time]. Pre-record sound segment has no such limit.

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Block Diagram

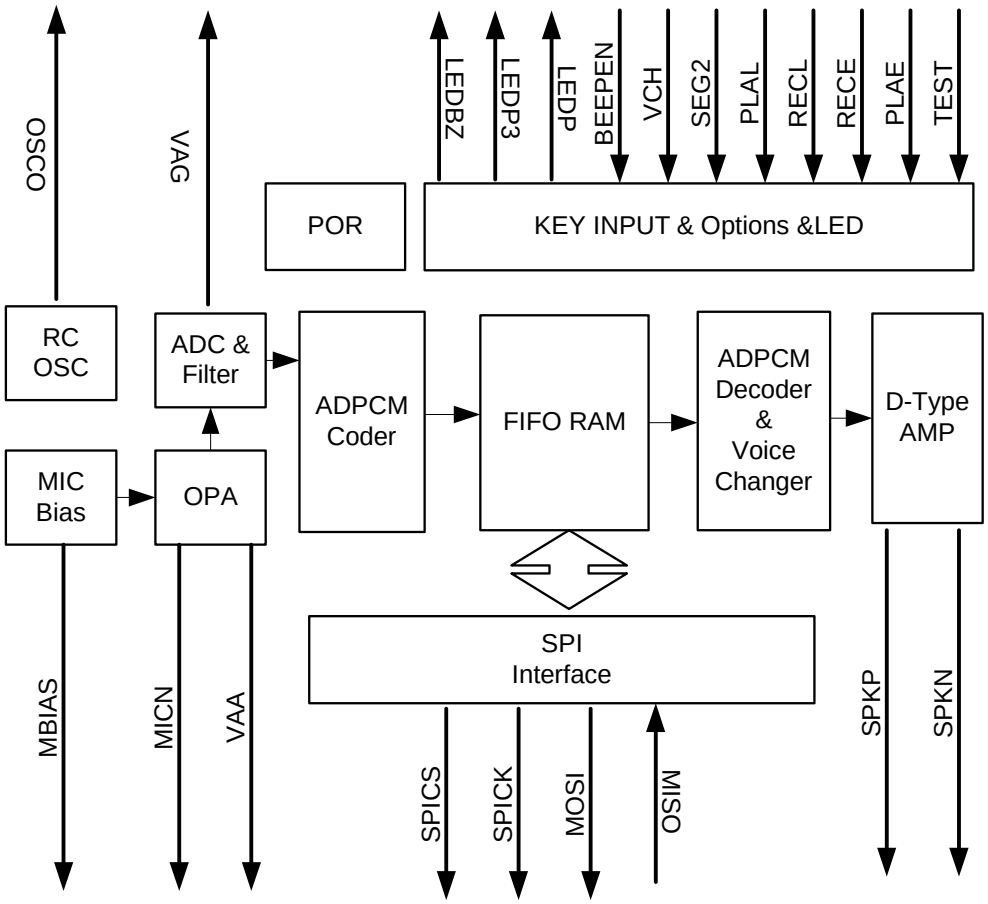

Figure 1. MS210 Block Diagram.

Application

- Sound recording toys, cards, and other applications.

Package

- SOP-28 PACKAGED.

General Description

MS210 is a recording IC that can be used for all kinds of sound recording applications. It can also be configured as a simplified band-limited sound amplifier. With different SPI flash memory connected, it can record sound up to 40 minutes with very good sound quality.

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PAD Configuration (Draft)

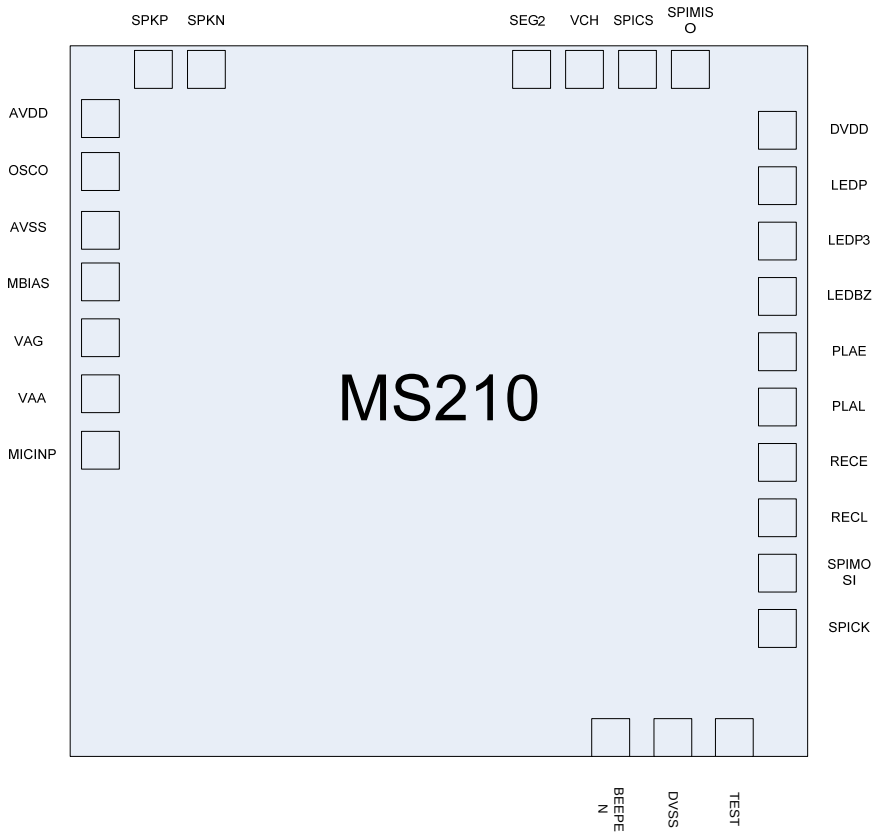

Figure 2. MS210 PAD Configuration

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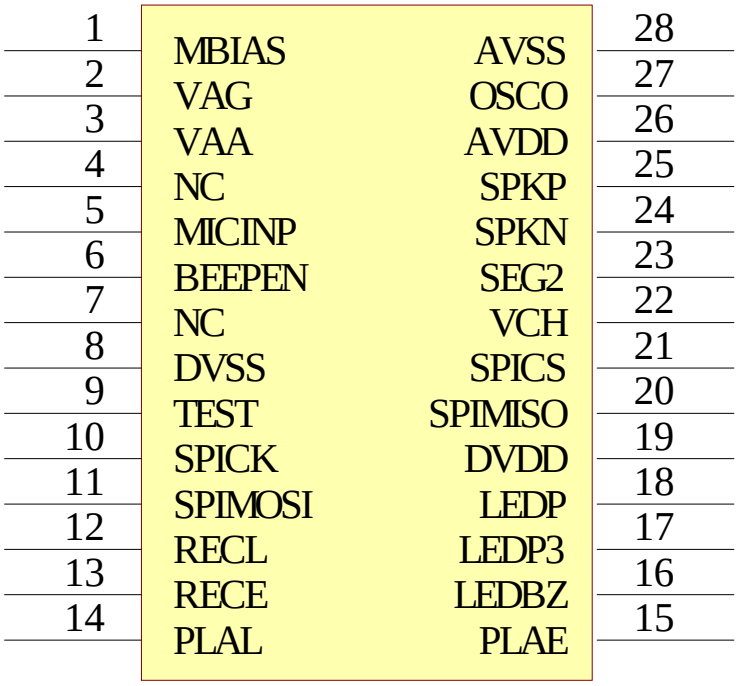
Pins Configuration



PKG Part No.MS210A28A

Figure 3. MS210 SSOP28 Package configuration.

Pin Descriptions

Pin No.	Notation	Type	Functional Description
Power Pins			
19	DVDD	Power	VDD power source of digital circuits.
8	DVSS	Power	GND power of digital circuits.
26	AVDD	Power	Analog/SPK Power VDD
28	AVSS	Power	Analog/SPK Power GND
Special Pins			

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27	OSCO	O	External resistor to DVSS
9	TEST	IU	Input low for test mode.
Key buttons & Options			
15	PLAE	IU[2]	Play button input. Edge Trigger. If the data is not played over, playing will stop at the second trigger. In 1-segment mode, only 1 segment will played. In 2 segment mode, 2 segment of voices will be played.
13	RECE	IU	Record start input. Edge Trigger. Second trigger will stop the record process. In 1 segment mode, MS210 will start recording at the beginning of the flash memory. In 2-segment mode, MS210 will start recording following the first voice segment.
14	PLAL	I[3]	Play, level trigger, low active. External pull-high resistor and de-bounce capaciator is required.
12	RECL	IU	Record, level trigger, low active.
22	VCH	I3[4]	Voice Changer option, Floating this pin has no sound effect. Short to GND will have pitch-shift effect. Short to VDD will have ROBOT effect.
6	BEEPEN	IUK[5]	Short this pin to GND will disable beep prompt when recording.
23	SEG2	I3	2 segment option pad.[6]

[2] IU means input with pull up resistor inside.

[3] I means input PAD only. No internal pull high or pull down resistor.

[4] I3 means the input PAD has 3 input states.

[5] IUK means the PAD will be pulled high when reset, but the internal pull high resistor will be off if it short to GND, when entering the idle/stop mode.

[6] SEG2 PAD state cannot change to/from floating state when operating with the same SPI Flash connected. Unknown playing result will happen if SEG2 is changed from floating state to VDD or GND.

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			This pin floating will play/record 1 segment only. If this pin short to VDD or GND, MS210 will use 2 segment mode. Short this pin to DVDD will play high address segment first. Short this pin to DVSS will play low address segment first. In 2 segment mode, MS210 will record the voice to replace the high-address segment. That is, low-address segment is the pre-load segment that can be music or others.
LED Pins			
18	LEDP	O	Output low when playing. **In 2 segment mode, it will output low when playing low-address segment only.**
17	LEDP3	O	Output 3 Hz when playing. High at recording or idle.
16	LEDBZ	O	Output 3 Hz when playing and output low when recording.[7]
SPI Pins			
21	SPICS	O	SPI Chip Select (Low active)
10	SPICK	O	SPI clock signal.
11	MOSI	O	Master data/command output.
20	MISO	I	Master data input.
Mic and Analog pins			
2	VAG	O	Analog virtual ground. Capacitor of 0.1 uF to AVSS is required. This pin is also the positive input of the OP-AMP.
3	VAA	O	Anti-Alias filter PAD. It is also the output of the OP-AMP.

[7] Recording indicator should use LEDP3 and LEDBZ as LED's supplies. When recording, LEDP3 will be high and LEDBZ will be low.

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1	MBIAS	O	Microphone bias.
5	MICNP	I	Negative input of internal OP-AMP. A feed back resistor and capacitor is required to connect VAA, and a resistor is used to connect the microphone.
Speaker Driving Pins			
25	SPKP	O	Speaker output. High-Z when not playing.
24	SPKN	O	Speaker output. High-Z when not playing.

Table 1. MS210 Pins Description.

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General Functional Description

MS210 is a simple chip that can record the voice from microphone/Speaker to SPI memory, and play the voice from SPI memory directly. It built in high-quality ADPCM engine that can compress the voice data from ADC to 4-bit per sample.

That is, when recording, sound are compressed to 4-bit per sample, and then stored to flash memory. While erasing sectors on SPI flash memory, MS210 will store the compressed speech data in its own RAM. After the sector is erased, the compressed data will be written to the SPI memory as soon as possible. Also, it will overwrite the old record data and replaced by the new one whenever a voice is recorded.

Before start recording a short Beep prompt will be on the speaker. And 2 short “beep” will out after recording stopped. Beep function can be disabled with BEEPEN short to GND.

In 1-segment mode, MS210 will record the speech from the beginning of the SPI flash. In 2-segment mode, MS210 will record (overwrite) the speech of high-address voice segment.

When playing, MS210 will read the content from the SPI memory and decode with ADPCM decoder, and perform the voice-changer function as required. In 1-segment mode, MS210 will play just one voice segment. In 2-segment mode, MS210 will play 2 segments of voices one by one. Which one should be played first is defined by PAD option.

MS210 playing is through D-Type Amplifier that has very good power efficiency and sound quality.

If TEST is low and SPIMISO is low, with PLAE connect to LEDBZ, MS210 will be act as band-limited amplifier like Figure 26.

Reset and Initialization

MS210 has default Power-On-Reset (POR) that release at about 1.8 V. After around 300 ms after power-on, MS210 will start to check the SPI flash memory connected. To power on correctly, the following constrains must meet:

1. Before Power ON, VDD Must be < 0.3V. (V1 in Figure 4 must less than 3V)
2. After Power ON, VDD must be higher than the voltage that the SPI flash can work (usually 2.4V or 2.7V). (V2 in Figure 4 must be greater than SPI Flash working voltage).
3. VDD Rise Time must be less than 0.2 second.
4. When power-ON, VDD curve must be monotonic. Bouncing between 0.3V~2.3V is not allowed.

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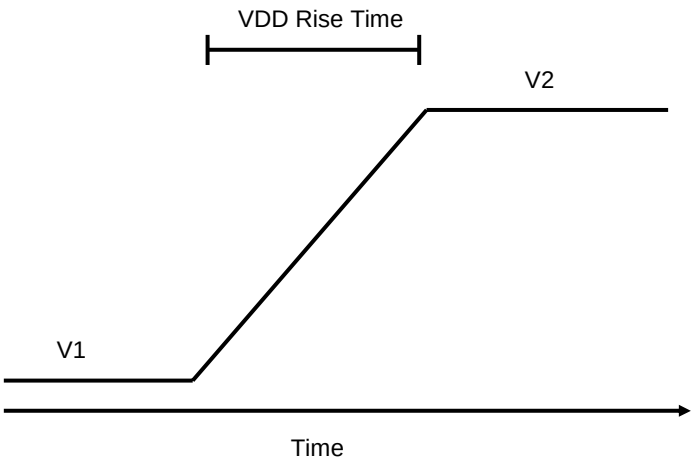

Figure 4. VDD Rise Time

If SPI Flash does not reply a valid size, MS210 will retry to get the size after a period of time. In 1-segment mode, MS210 will go to sleep with DS command of the memory after memory size is checked. In 2-segment mode, MS210 will find the end (sector address) of the first voice segment after reset.

Manual Reset

If MS210 is used in bad power conditions, or changing flash memory is required, manual reset is another option. MS210 will enter “RESET” state if “TEST” and “BEEPEN” short to GND at the same time. The configurations are as below:

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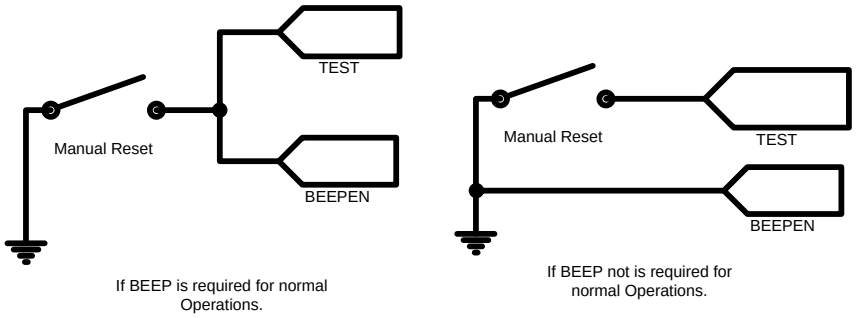

Figure 5. Manual Reset.

If normal operations do not “BEEP”, BEEPEN may short to GND constantly, and use TEST pin as the reset pin.

Used SPI Commands

The SPI flash connected must support the following commands:

COMMAND NAME	COMMAND CODE	DESCRIPTION
JEDEC ID	9FH	Read the standard size information. MS210 Checks the 3rd byte reply of command 9F as its size code. The mapping is as below: Command 0x9F reply 3rd byte / Size 0x10 / 512K Bits 0x11 / 1M Bits 0x12 / 2M Bits 0x13 / 4M Bits 0x14 / 8M Bits 0x15 / 16M Bits 0x16 / 32M Bits **0x17** / 64M Bits
DS release	ABH	Read the signature or release from the deep sleep mode.
Read Status Register	05H	Read the 8-bit register to know if busy.

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Write Status Register	01H	Write the 8-bit register.
Write Enable	06H	Write enable
Sector Erase	20H	Erase 4 Kbyte sector.
Page Program	02H	Program 256 bytes.
Deep Power Down	B9H	Deep power down of the SPI Flash memory.
Data Read	03H	Read the SPI flash memory.

Table 2. Used SPI commands.

New SPI Memory parts must have above commands if connecting to MS210.

Recording Function Description

MS210 will record the signal of microphone to the SPI Flash Memory, the following sub-sections will describe the detailed information.

Record Timing

When recording, MS210 has input signals and LED output like the figure below. Note that LEDP3 and LEDBZ can be used for recording indicator.

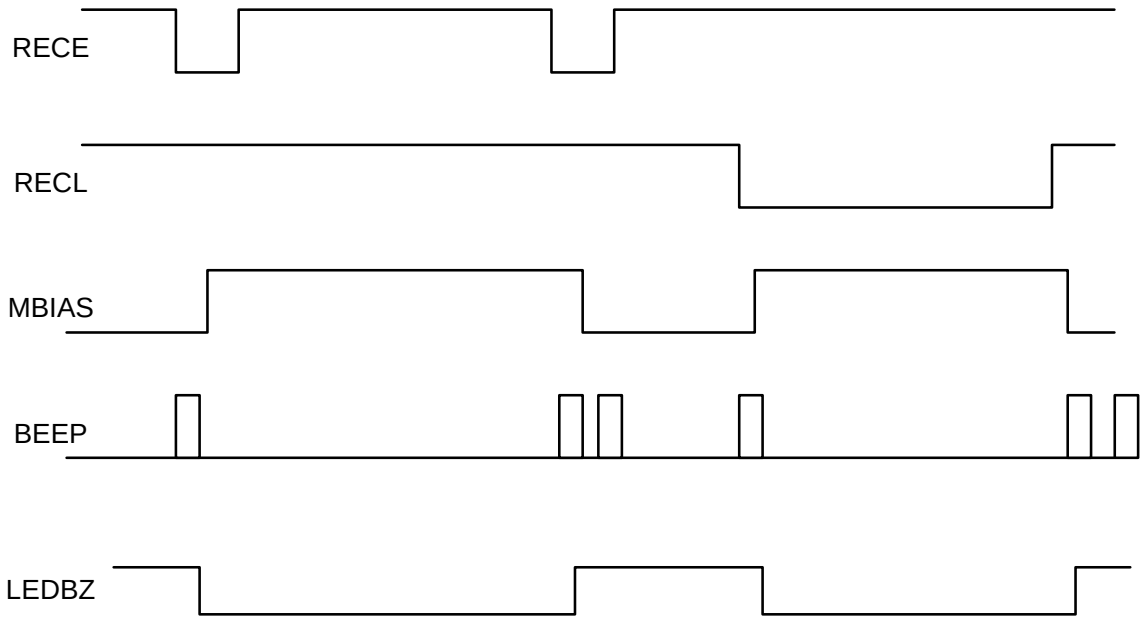

Figure 6. Record Timing Diagram.

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Recording Signal Path

When recording, MS210 has the recording signal path as below.

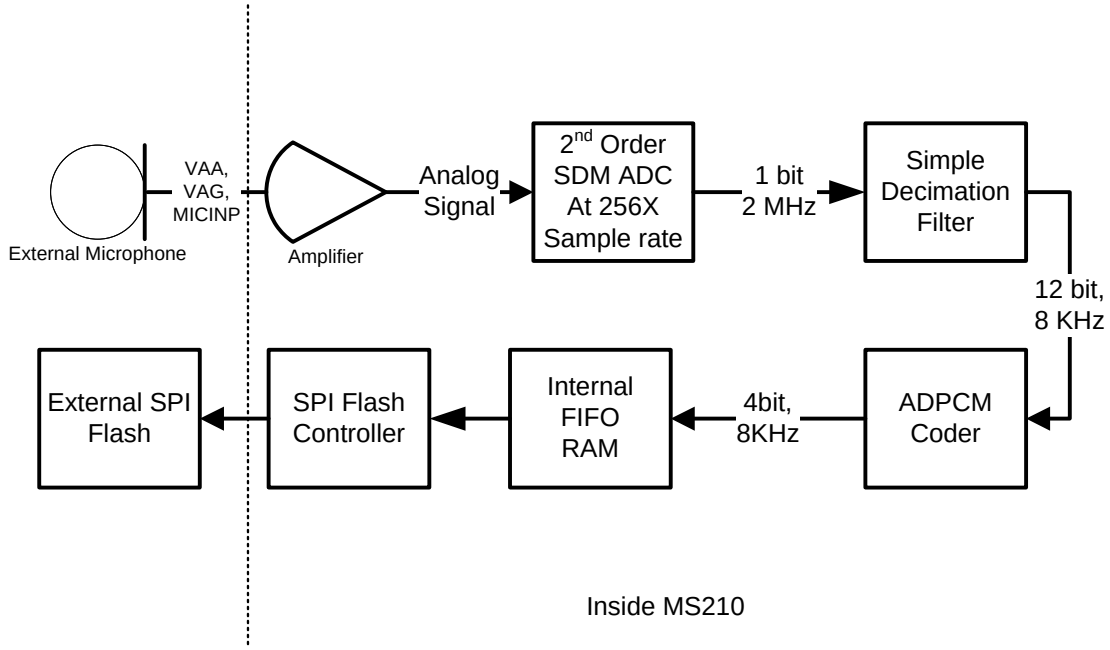

Figure 7. MS210 Recording data path.

When recording a segment, the sound signal will be sensed with external microphone and amplified by the built-in OP-AMP of MS210. The signal will be converted to digital signal first by the 1-bit, 2nd order sigma-delta ADC, which is normally working at 2.0 MHz, or at 256 times over-sample-rate.

The sampled data will be down-sampled to normal sample rate (8K) with a simple decimation filter, which is the structure below:

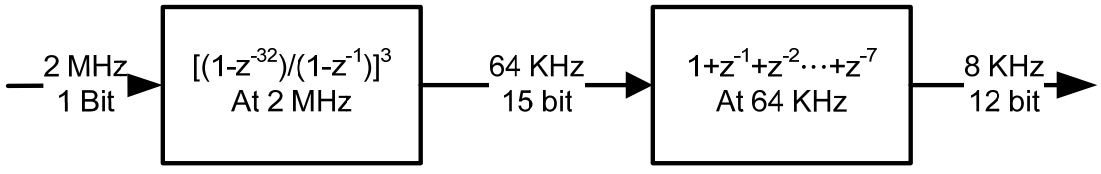

Figure 8. MS210 Decimation Filter.

The filter samples the signal at 64 KHz first, then down to 8 KHz at last. It is low cost[8] and has not high Q for

[8] Don't expect too much, MS210 is very cheap.

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high-frequency noise rejection, but will be enough for normal recording applications. The combined Frequency response of the digital filter is as below:

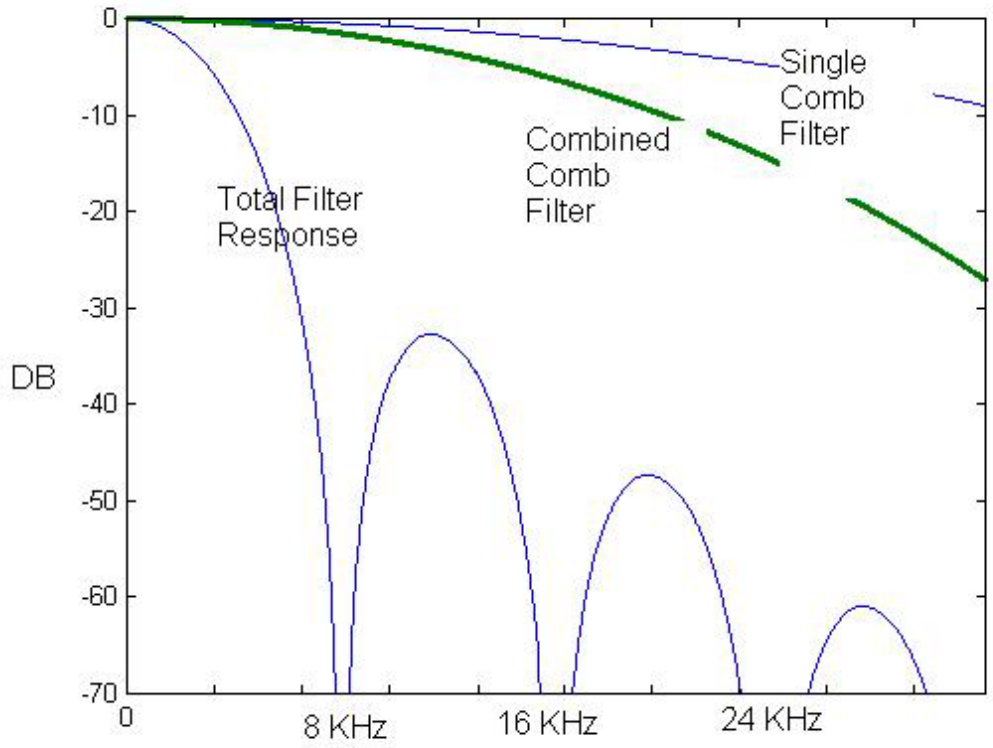

Figure 9. Decimation Filter Response with 8 KHz sample rate.

The combined filter response in in-band frequency is as Figure 10, which shows that the filter will have in-band filtering of 3.0 KHz around 5 DB, and 4.0 KHz of 8 DB.

That is, MS210 ADC is better working with the external analog filter, with higher sampling rate. If sampling rate at 16.0 KHz and OP-AMP with external components can provide better rejection of signals higher than 8.0 KHz, the recording effect will be very good.

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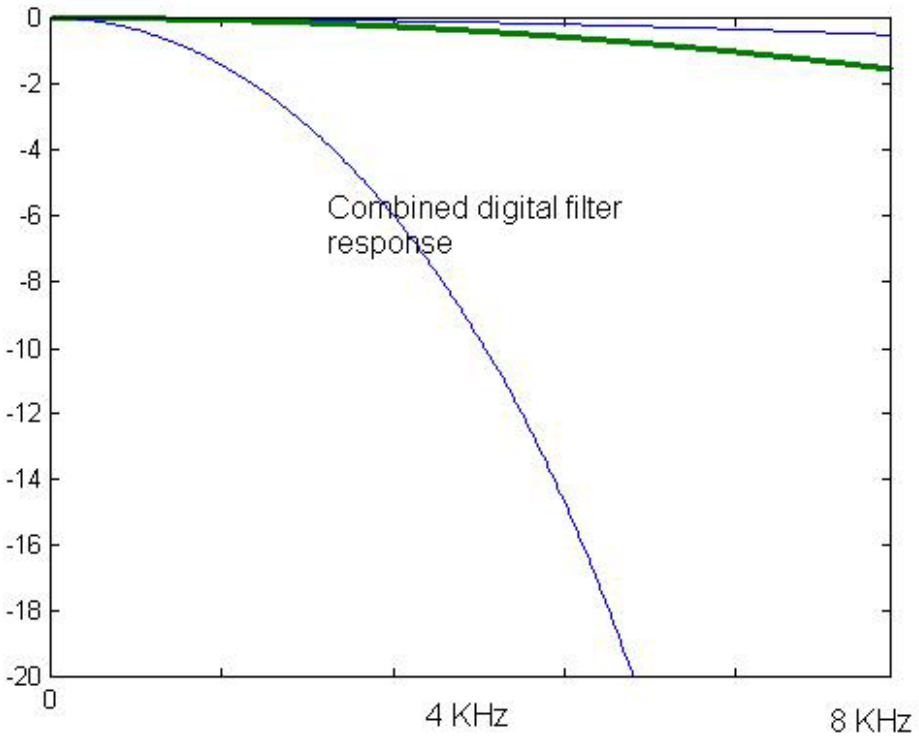

Figure 10. Decimator Filter Response with 8 KHz sample rate.

Microphone Amplifier Circuits

MS210 has an OP-AMP that can amplify the audio signal as required. Usually the external components are as follows.

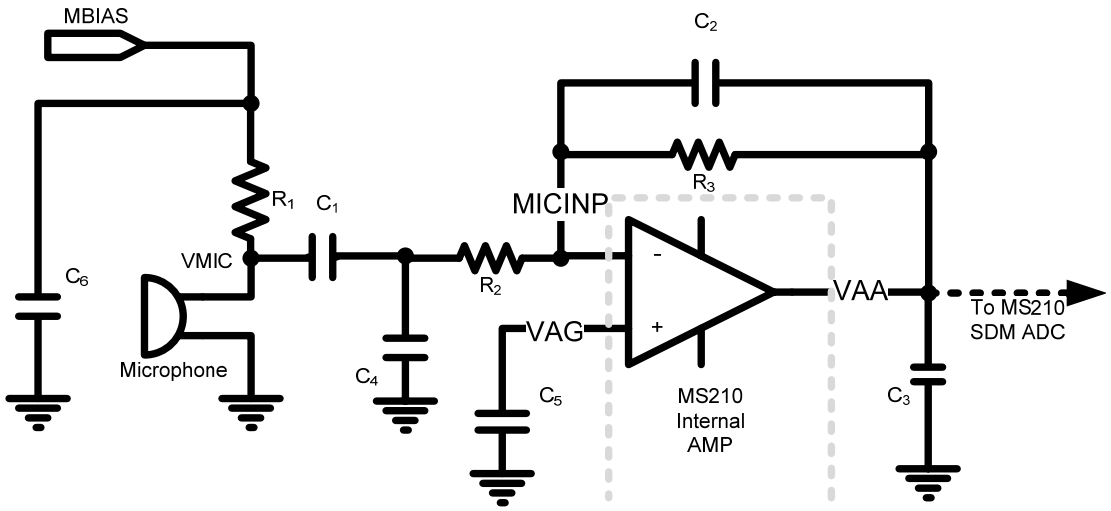

Figure 11. MS210 Amplifier Components.

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From Above figure, the OP-AMP with its external components forms a band-pass filter, which has gain and related frequencies described below:

1. MBIAS will output a constant current source if external load need current more than 3 mA. Otherwise, it will be as high as AVDD.
2. R1 provides the loading of the microphone. Usually it is 1K ohm to 3K ohms.
3. If C_4 is small, R_2 is the input impedance of the amplifier. If R_2 >> R_1, we have the high-pass 3db frequency at **$1/(2\pi R_2 C_1)$**. If R_2 is 10K Ohms, C_1 is 0.1 uF, the 3DB frequency is around 160 Hz. For speech signal, usually we need 300 Hz ~ 3000 Hz be clearly amplified, and 160 Hz will be a good value.
4. R_3/R_2 decides the gain of the amplifier. Note that the OP-AMP has unit-gain-bandwidth at around 1.0 MHz. That is, if gain is 200 (26db), it will have the 3-db frequency at 5 KHz event C_2 is not connected. BTW, R_2 must be much greater than R_1 to get the microphone load line correct. That is, the following equation is usually applied:
   a) R_2 >= 10 K Ohms.
   b) Gain = R_3/R_2
5. C_2, C_3, C_4 forms the low pass filter of the amplifier. C_4 is used to prevent noise generated by special housing of microphone, and C_3 can usually be omitted because SDM samples the data at 2.0 MHz, which usually do not need an anti-alias filter for 1.0 MHz signal and up. The low pass frequency is mainly dominated by C_2 and the unit-gain-BW of the OP-AMP. If gain is less than 30 dB, the low-pass will be dominated by C_2 and R_3 at **$1/(2\pi R_3 C_2)$.** If R3 is 2 M Ohms, C2 is 22 pF, the 3db frequency will be 3.6 KHz.

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SPI Flash Recording Flow

When RECE or RECL pressed, MS210 de-bounce the key for around 30[9] ms, and will beep[10] for 0.2 second. After another 0.3 second, MS210 will start recording.

While BEEP, MS210 will give "wake up" command to SPI Flash. After 0.5 second[11], the ADPCM Coder will keep write to RAM every 1/4000 second, and MS210 will start give the following command to the SPI Flash.

1. Unprotect. Some SPI flash will be protected after power ON. MS210 will unprotect it.
2. Sector Erase.
3. Send program command, with data read from the FIFO RAM.
4. If a page is full, it will wait FLASH to write the data.
5. If a new sector is required, it will go to step 1.
6. If FIFO is empty it will wait for the data.
7. If edge triggered recording, it will stop recording when any key pressed.
8. If RECL is low, it will stop recording when it released.

That is, the timing is like Figure 12.

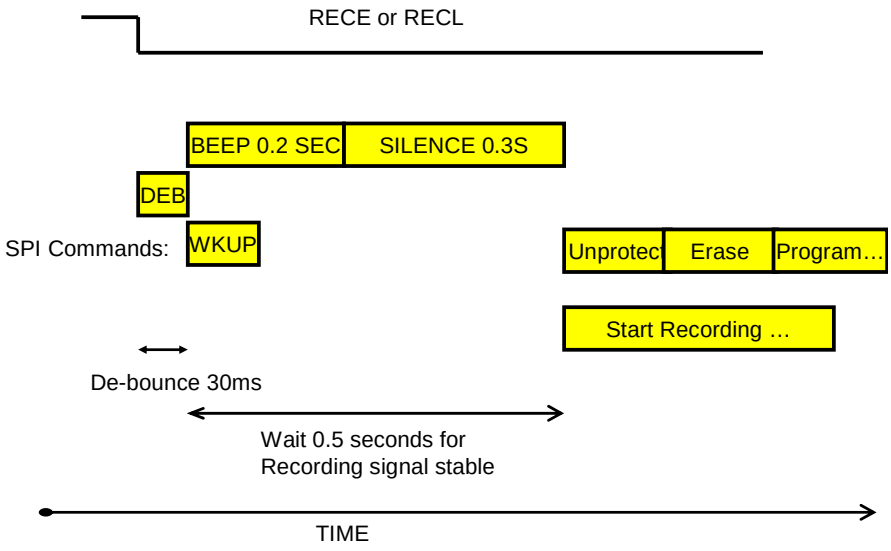

Figure 12. Operations when recording starts.

[9] When sample rate is 8 KHz, it will de-bounce for 30 ms. If sample rate is 16 KHz, it will de-bounce for 15 ms, etc.

[10] If BEEPEN is short to GND, MS210 will just keep silence at the following 0.3 seconds.

[11] If RECL is released in 0.5 second, no data will be stored to SPI Flash, and old data on Flash will be kept.

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SPI Power Noise Rejection

When recording, SPI flash always generates large noise on power signals. This is because the internal charge-pump will be enabled when erasing the sector before record sound information to it, and programming the flash will also use more power than idle states. When recording, sound information is record in “pages”, and generates noise around 32 Hz. The noise is annoying and need to be filtered clearly. Small noise in MBIAS will be amplified by OP-AMP and be recorded.

Instead of regulated VAG and MBIAS signal, MS210 uses “dynamic” method to reduce the power noise as the following figure.

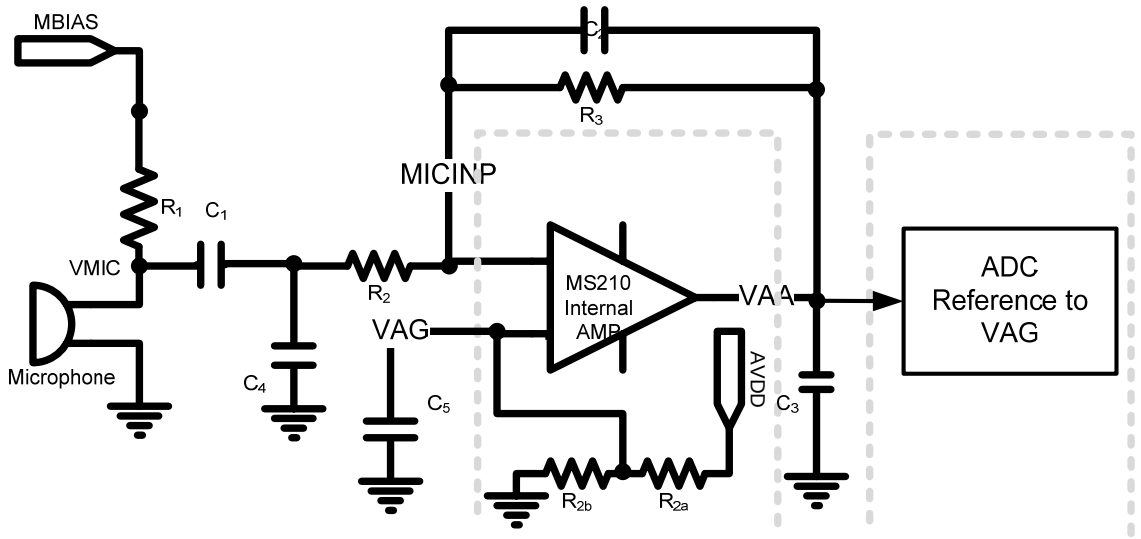

Figure 13. Power Noise Rejection Figure

If AVDD has an additive noise N(t), VAG will have noise $N(t)*R_{2b}/R_{2a}$[12].

Also, because MBIAS has also the noise from AVDD, and VMIC has noise N’(t). If $R_2>>R_1$, VAA will have signal as follow:

$$VAA = \left(N'(t) - N(t) \bullet \frac{R_{2b}}{R_{2a} + R_{2b}} \right) \bullet \frac{R_3}{R_2} \qquad \text{Eq. 1}$$

ADC result will be VAA-VAG, which is the following equation:

[12] Assume the power noise is low frequency that C5 has no effect.

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$$VADC = \left(N'(t) - N(t) \bullet \frac{R_{2b}}{R_{2a} + R_{2b}} \right) \bullet \frac{R_3}{R_2} - N(t) \bullet \frac{R_{2b}}{R_{2a} + R_{2b}}$$

$$= \left(N'(t) - N(t) \bullet \left(\frac{R_{2b}}{R_{2a} + R_{2b}} - \frac{R_2}{R_3} \bullet \frac{R_{2b}}{R_{2a} + R_{2b}} \right) \right) \bullet \frac{R_3}{R_2} \qquad \text{Eq. 2}$$

$$\cong \left(N'(t) - N(t) \bullet \frac{R_{2b}}{R_{2a} + R_{2b}} \right) \bullet \frac{R_3}{R_2}$$

Since R3/R2 is large, and R2/R3 is very small. We can consider only the large part. From Eq. 2, we know if VADC will be almost zero if the following condition is true.

$$N'(t) \cong N(t) \bullet \frac{R_{2b}}{R_{2a} + R_{2b}} \qquad \text{Eq. 3}$$

That is, if the microphone's impedance is "almost" resistive, we can assume that if **DC of VMIC is equal to DC of VAG**, the noise can be cancelled mostly. Because VMIC has noise from AVDD (MBIAS) around N(t)*RMIC/(R1+RMIC). If that value is equal to VMIC, the DC values of them are almost the same.

Above theory applies when the noise on AVDD/AVSS is small and has very quiet and has few harmonic power.

For NO-MIC recording applications, no power noise will be generated theoretically.

Playing Function Description

MS210 can play the recorded sound from the SPI Flash memory. The following subsections will describe the playing function in detail.

Playing Timing Diagram, 1-SEG Mode (SEG2 pin floating)

When PLAE or PLAL pressed, MS210 will start to play. The LED and sound segment timing is as the following figure, when SEG2 pin is floating.

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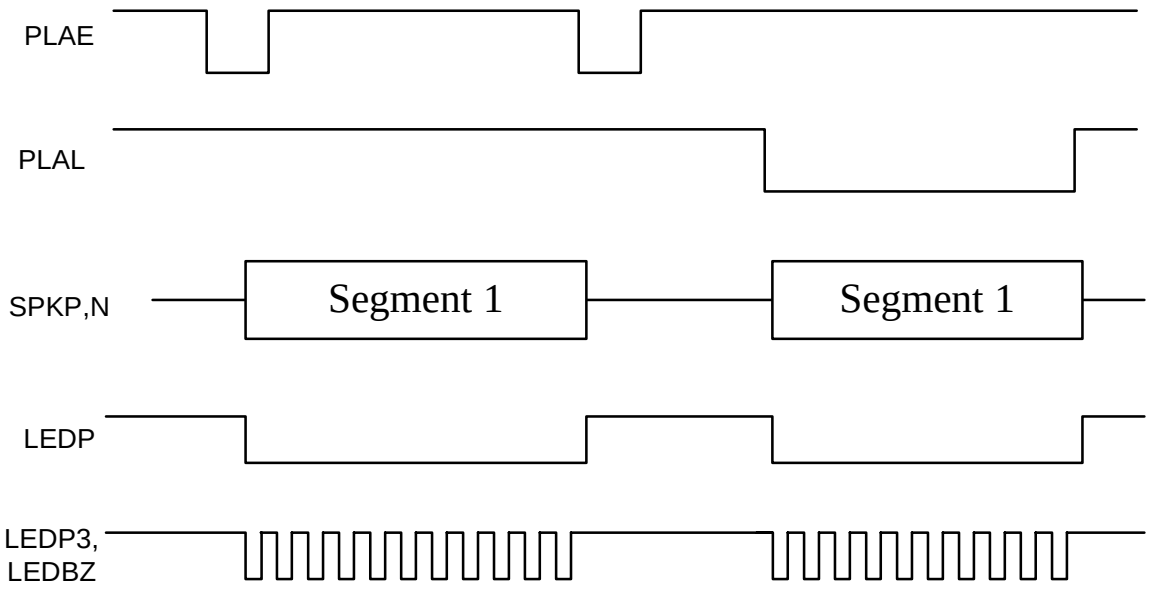

Figure 14. Playing Timing Diagram.

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Playing Timing of 2-SEGMENT Mode

Also, MS210 can play 2 segments with a segment fixed. The timing is as Figure 15 and Figure 16. Figure 15 has SEG2 short to GND, and Figure 16 has SEG2 short to VDD.

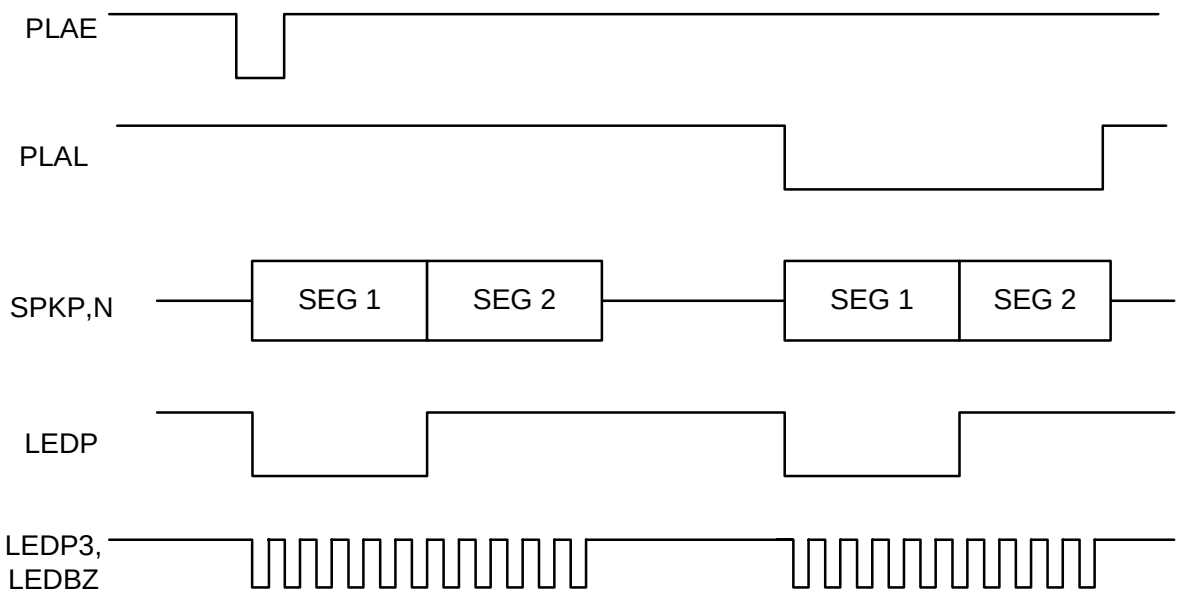

Figure 15. Playing 2-segment Mode. (Low address first)

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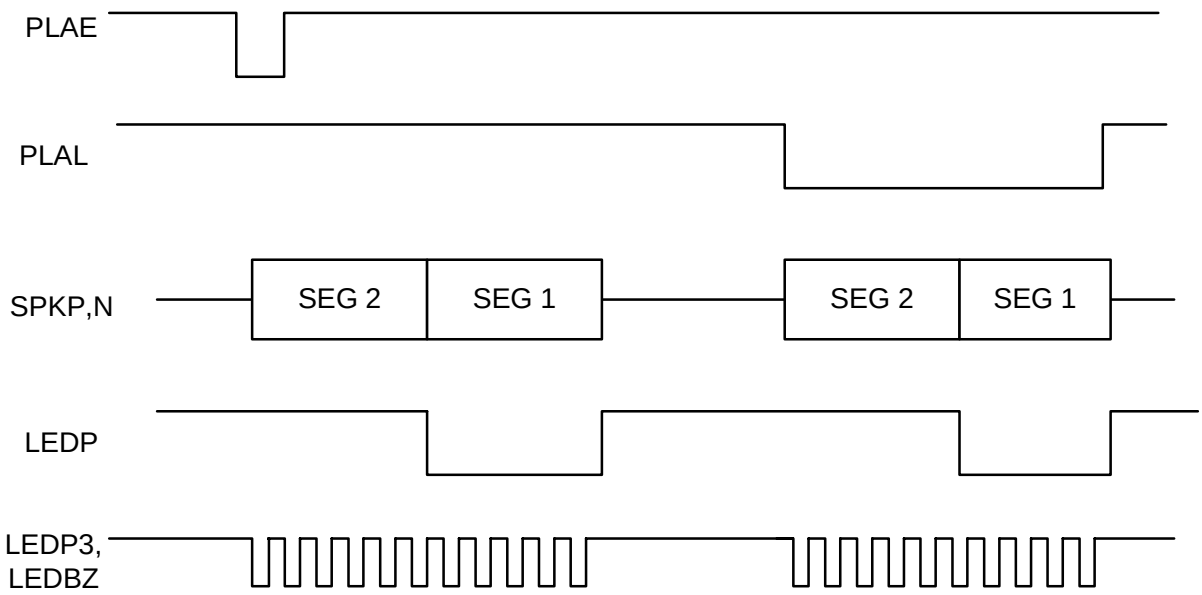

Figure 16. Playing 2-segment Mode. (High address first)

Note that LEDP low at only first segment. This can be used for different sample rate configuration for preload song and recording voice. “Sample Rate and Resistor” Section has detailed description.

RECL over PLAL

MS210 has a special function about the key buttons that PLAL function can be interrupted by RECL. That is, when PLAL and RECL are low at the same time, RECL function will always overtake PLAL function. The function is suitable for card applications that external photo resistor is only required at PLAL pad.

That is, if PLAL is low, PLAE and RECE keys will have no function. However, if RECL is low, MS210 will change to recording mode, and when RECL is released, MS210 will play again the newly record segment. After the new segment is played, MS210 will enter sleep mode even PLAL is low.

The timing diagram is as below:

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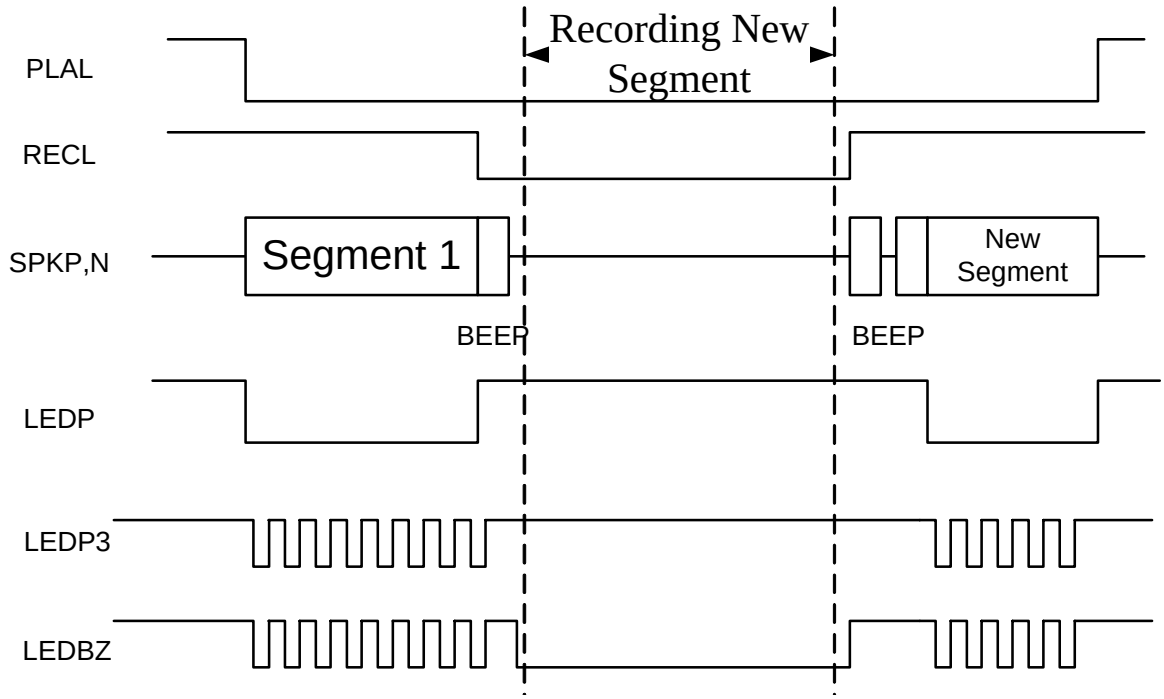

Figure 17. RECL interrupt PLAL function.

Signal Flow When Playing

When MS210 playing, the signal will be strait-forward as Figure 18. The data will be read from the SPI flash and interpolated to the amplifier.

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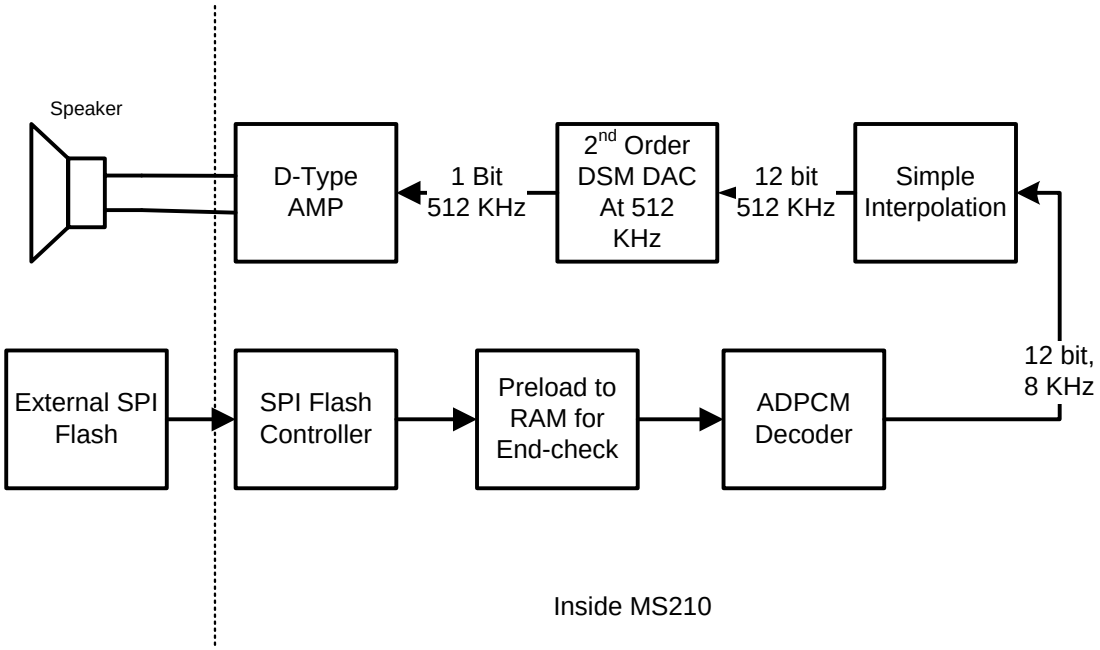

Figure 18. Playing signal flow.

Playing-Stop Condition

When playing, MS210 will check the following condition to stop playing:

1. If PLAE pressed, it will stop when any other button pressed.
2. If PLAL pressed, it will stop when PLAL released.
3. If MS210 found 0xFF for 8 times, it think it is the end-code, and will stop playing.
4. If entire flash played, it will also stop.

Connecting External Power Amplifier

MS210 can connect external power amplifier with differential or single-ended method. The following chart shows MS310 connecting to power-amplifier with differential method (BTL Mode). Note that SPKP and SPKN is high impedance when not playing.

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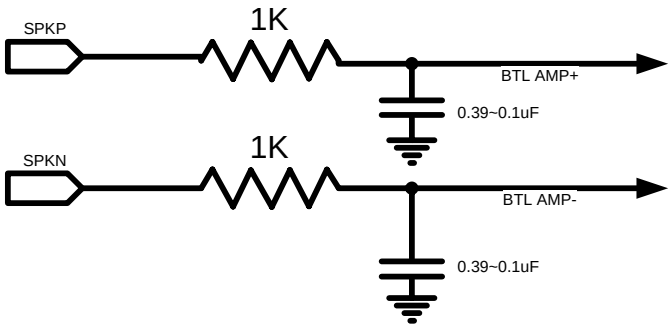

Figure 19. MS210 Connecting external amplifier of BTL Mode.

Or, MS210 may drive external MOSFET as high power amplifiers. The following shows the power up to 1 Watt amplifier.

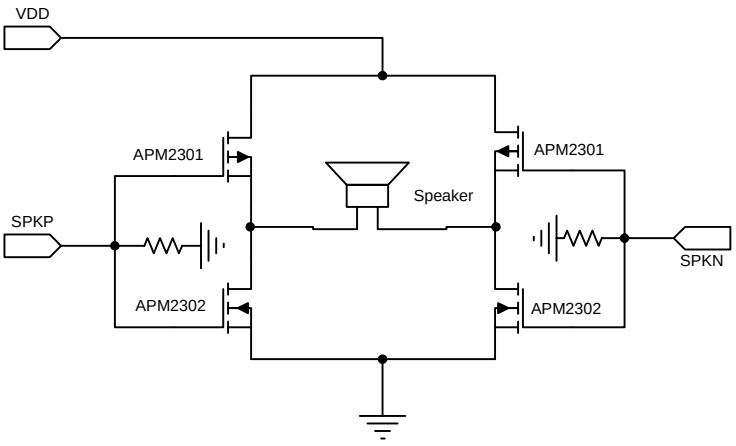

Figure 20. MS210 with external amplifier up to 1 Watt.

Also, if another high voltage power is available, 10 Watt amplifier may be available as below:

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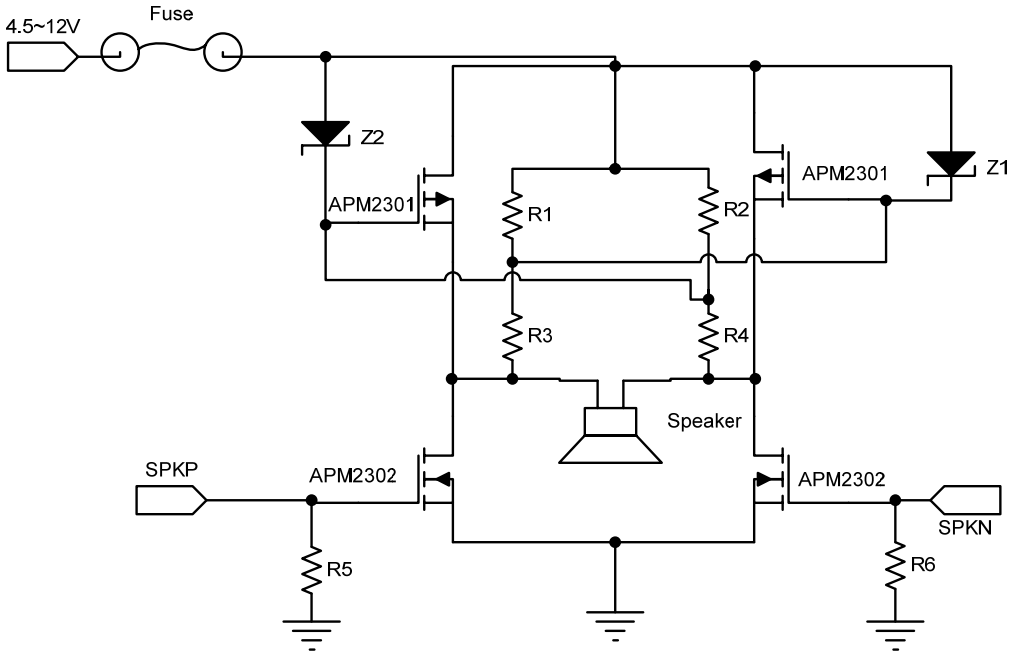

Figure 21. MS210 with external amplifier up to 10 Watt or more.

In Figure 21, protection circuits are used to protect the MOSFET. The Zenner Diodes Z1 and Z2 are used to prevent break-down of APM2301, and the fuse is to prevent over-current. R5 and R6 are around 10K ohms and used to prevent both ON when not playing.

If the MOSFET changed to more high-voltage ones, above circuit may be used at higher voltage environments.

Voice Changer Function

MS210 has 2 voice changer function option. When enabled, it will have the sound effect **when playing**. When VCH connect to GND, MS210 will have Pitch-shift effect that playing frequency will be 150% of recording frequency. The entire signal flow has no change.

When VCH connect to VDD, MS210 will have “ROBOT” effect. The ROBOT effect is by the following steps:

1. Decode 4096 samples,
2. Save the first 1024 samples to RAM. (8-bit).
3. Repeat playing the 1024 samples from RAM for 4 times.
4. Go to step 1.

That is, the signal flow will be changed for “ROBOT” effect as below:

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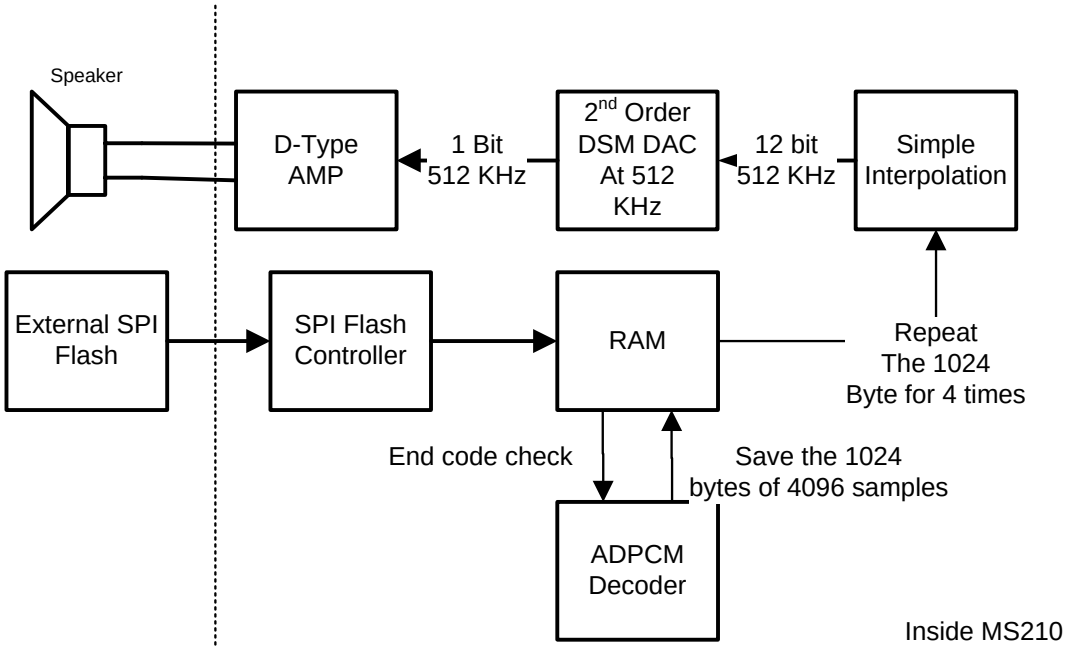

Figure 22. Signal Flow for ROBOT Effect.

The result recording and playing waveform will be like below:

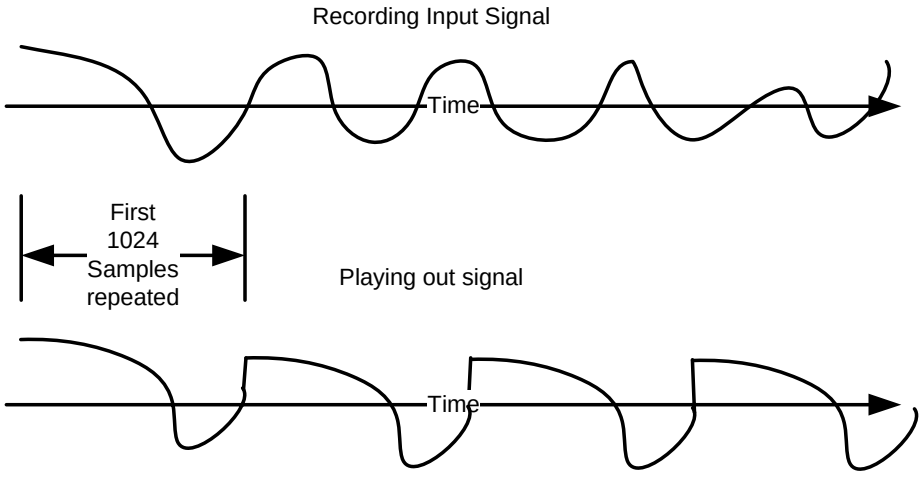

Figure 23. Example waveform of ROBOT Effect.

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ADPCM Coder and Decoder (CODEC)

MS210 has built-in ADPCM codec for saving the space of SPI Flash Memory. The CODEC is suitable for speech signal. MSHINE provide a tool program that can code a sound file manually to MS210's format and can be used for 2-segment applications.

Note that coder and decoder can not work at the same time. MS210 will not enable CODEC in Pure-Amplifier Mode.

Sample Rate and Resistor

For different sample rate, resistor of correct value should connect to OSCO pin. The recommend value is as below (At 3.0V):

SAMPLE RATE (KHZ)	8.0	6.0	10.0	12.0	16.0
Typical Resistor (K Ohms)	91	120	73	62	47

Double Sample Rate Configuration

In 2 Segment mode, playing the "preload" segment may use different sample rate from default one. That is, MS210 may play the preload song with higher sample rate and record the "high" address segment with lower sample rate. The following configuration will have preload song played at 22 KHz and record/play the voice at 12.0 KHz.

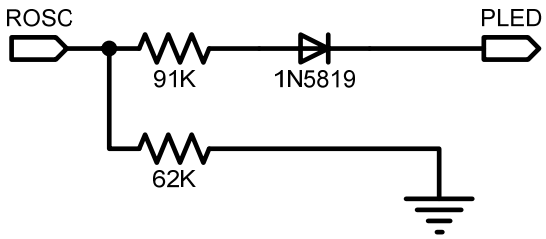

Figure 24. Example Double Sample Rate Configuration.

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Typical Application Circuits

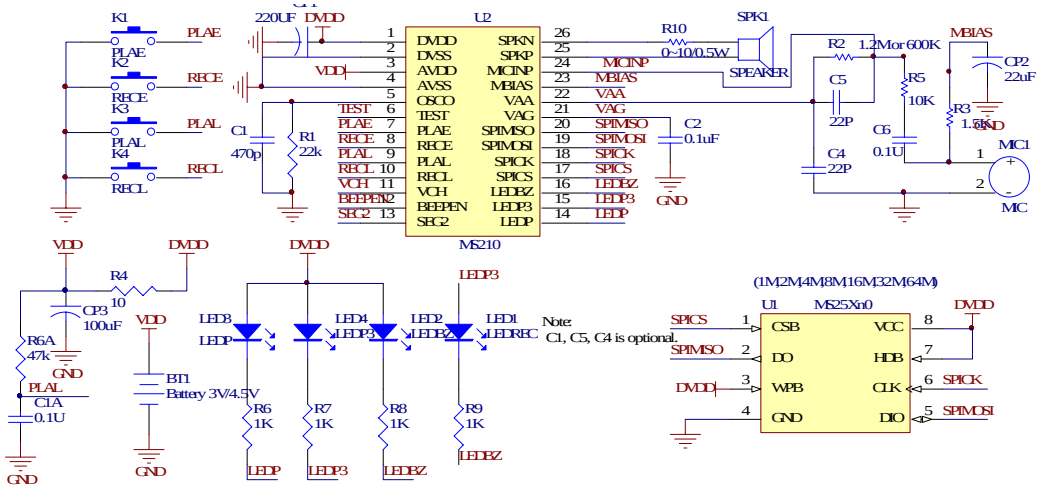

Figure 25. Typical Application Circuit for Recording Application.

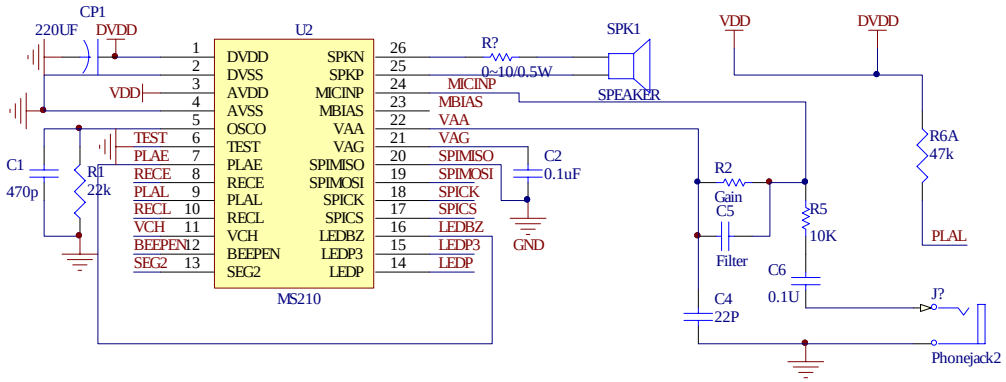

Figure 26. Typical Application for simple Amplifier.

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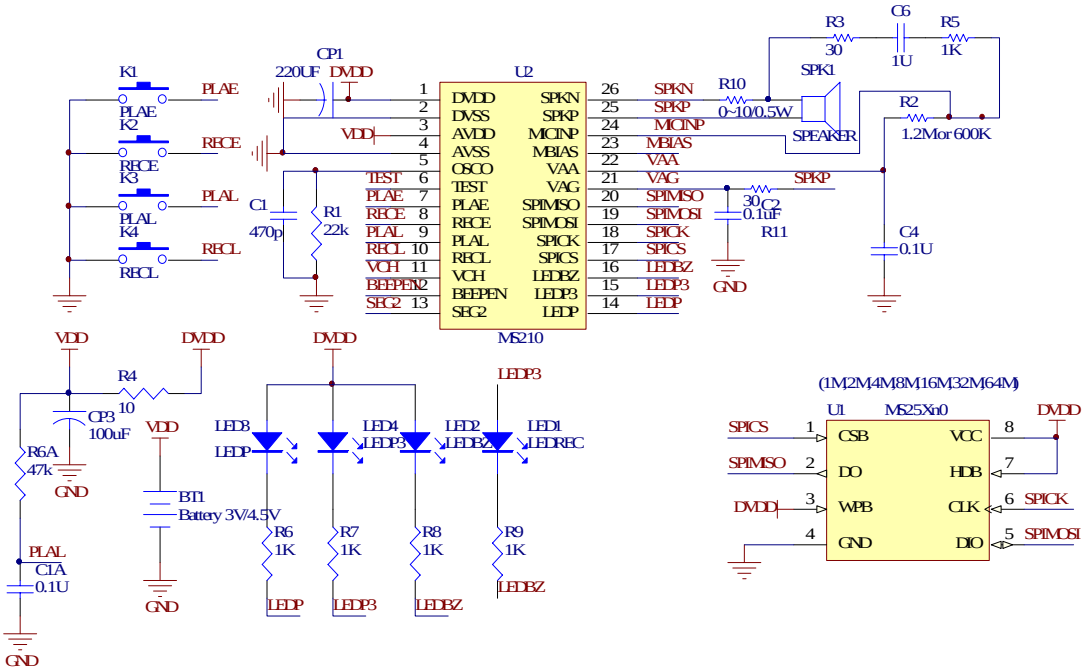

Figure 27. Typical Application for NO-MIC recording.

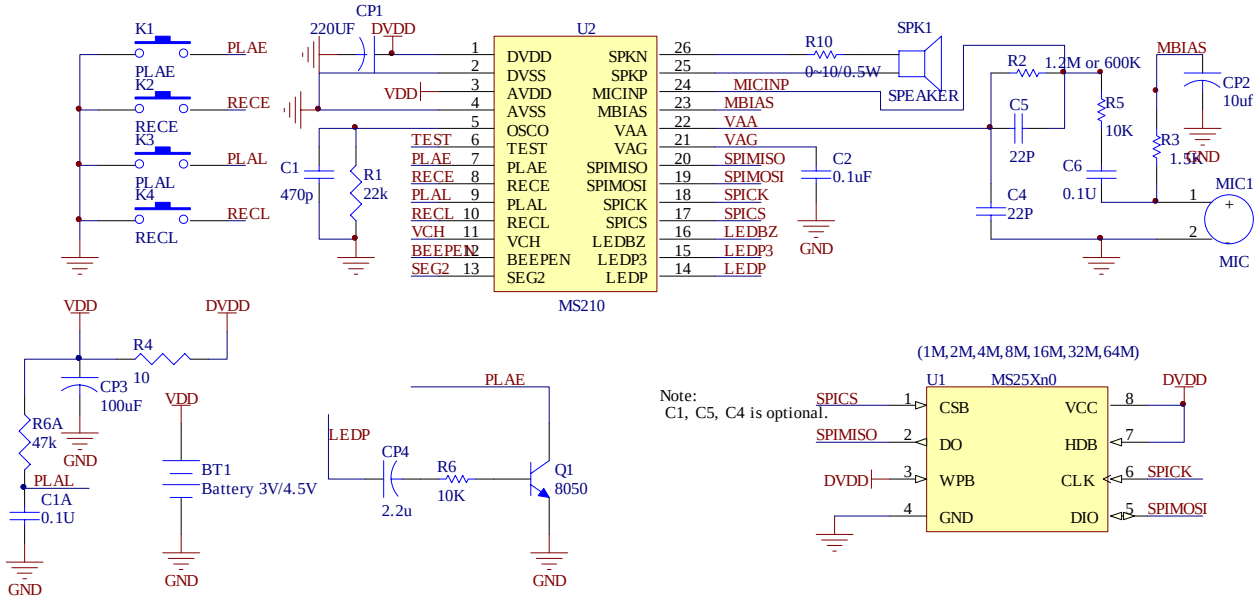

Figure 28. MS210 with Auto-Repeat modification.

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Absolute Maximum Ratings

Comments

DC Supply Voltage.....-0.5V to + 4.5V
Input Voltage……..-0.5V to VDD + 0.5V
Output Voltage……-0.5V to VDD + 0.5V
Operating Temperature….....-40° to 85° C
Storage Temperature……..-70° to 150° C

Never allow a stress to exceed the values listed under "Absolute Maximum Ratings", otherwise the device would suffer from a permanent damage. Nor is a stress at the listed value be allowed to persist over a period, since an extended exposure to the absolute maximum rating condition may also affect the reliability of the device, if not causing a damage thereof.

AC & DC Electrical Characteristics

DC Characteristics

Parameters	Conditions	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	With SPI flash working at 4.5V	V_{DD}	2.2[13]	3.3	4.5[14]	V
	VDD Before Power ON	V_{DDOFF}			0.3	V
	VDD Rise Time	T_{VDDR}			200	ms
Supply Current	8KHz, recording, VDD=3.0V	I_{REC}		10		mA
	8KHz, playing, VDD=3.0V, 8-Ohm speaker	I_{PLA}		20		mA
	Power-Down Mode, 3.0V[15]	I_{DD1}		2	10	uA
	Power-Down Mode, 3.6V	I_{DD2}		7		uA
	Power-Down Mode, 4.5V	I_{DD3}			100	uA
Output voltage	I_{OH}=1, Push-pull pins.	V_{OH1}	VDD-0.2	-	-	V
	I_{OL}=2 mA, push-pull pins	V_{OL1}	0.2	-	-	V
Input voltage[16]	All Input Pins	V_{IH1}	0.8 V_{DD}	-	V_{DD}+0.3	V
	All Input Pins	V_{IL1}	-0.3	-	0.2 V_{DD}	V
Output current	LED pins, VOL=0.5V, VOH=VDD-0.5V	I_{OL1} I_{OH1}	8		-8	mA
	AMP pins, 8-ohm speaker connected	I_{OL2} I_{OH2}		-100 +100		mA
	KEY pulled high input at 4.5V	I_{PH}		-0.9		mA
	KEY pulled high input at 3.6V	I_{PH}		-0.6		mA
MBIAS Output Current	VDD=3.3V	Imbo		3		mA
VAG output Voltage	VDD=3.3V	Vag		0.9		V

[13] The supply voltage MUST be greater than the working voltage of the SPI Flash Memory.

[14] When VDD>=3.3V, 8-ohm speaker must be connected with a resistor and an inductor.

[15] SPI Flash's power is not included.

[16] Schemitter Trigger level around 2VDD/5, 3VDD/5 is implemented for all input pins.

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POR Release voltage	Temp=23° C	Vpor		1.8		V

Table 3. DC Characteristics of MS210.

AC Characteristics

Parameters	Conditions	Symbol	Min.	Typ.	Max.	Unit
Key button De-bounce time	Sample Rate = 8.0 KHz	Tkd		30		ms
ADC Input Range[17]	VDD=2.3~4.5V	Vadi	0.25		2.25	VDC
External RC Frequency	VDD=2.3~4.5V	Frc		8		MHz
ADC Sample rate[18]	VDD=3.0V	FS	6	8	16	KHz
Speech Signal SNR	VDD=3.0V	ADC_{SNR}		60[19]		DB
Speech Dynamic Range	VDD=3.0V	ADC_{SNDR}		70		DB
MBIAS Driving Current	VDD=3.0V	IMBIAS		2		MA
ADC POWER NOISE REJECT	VDD=3.0V	PSRR		50		DB
ADC COMMON MODE REJECT	VDD=3.0V	CMRR		40		DB
Input OPA Open loop gain	VDD=3.0v	G_{OL}	70			DB
OPA Input offset	VDD=3.0V	Oop			10	mV
OPA Unit gain bandwidth	VDD=3.0V	BWuni		1		MHz
MBIAS Power Noise Reject Ratio[20]	VDD=3.3V,load=2.0 mA	PSRRmb		15		db

Table 4. AC Characteristics.

[17] ADC input will be DC offset to VAG by OPA inside, which is usually VDD/2.

[18] ADC Sample rate is limited by the sector-erase time with the memory since higher frequency needs more data stored at RAM when SPI is under sector-erase. The sample rate limit is [2560/sector-erase-time]. That is, sound sample will be dropped while recording if sample rate is greater than [2560/sector-erase-time].

[19] Input signal is around 100 Hz sine wave.

[20] Without capacitor.

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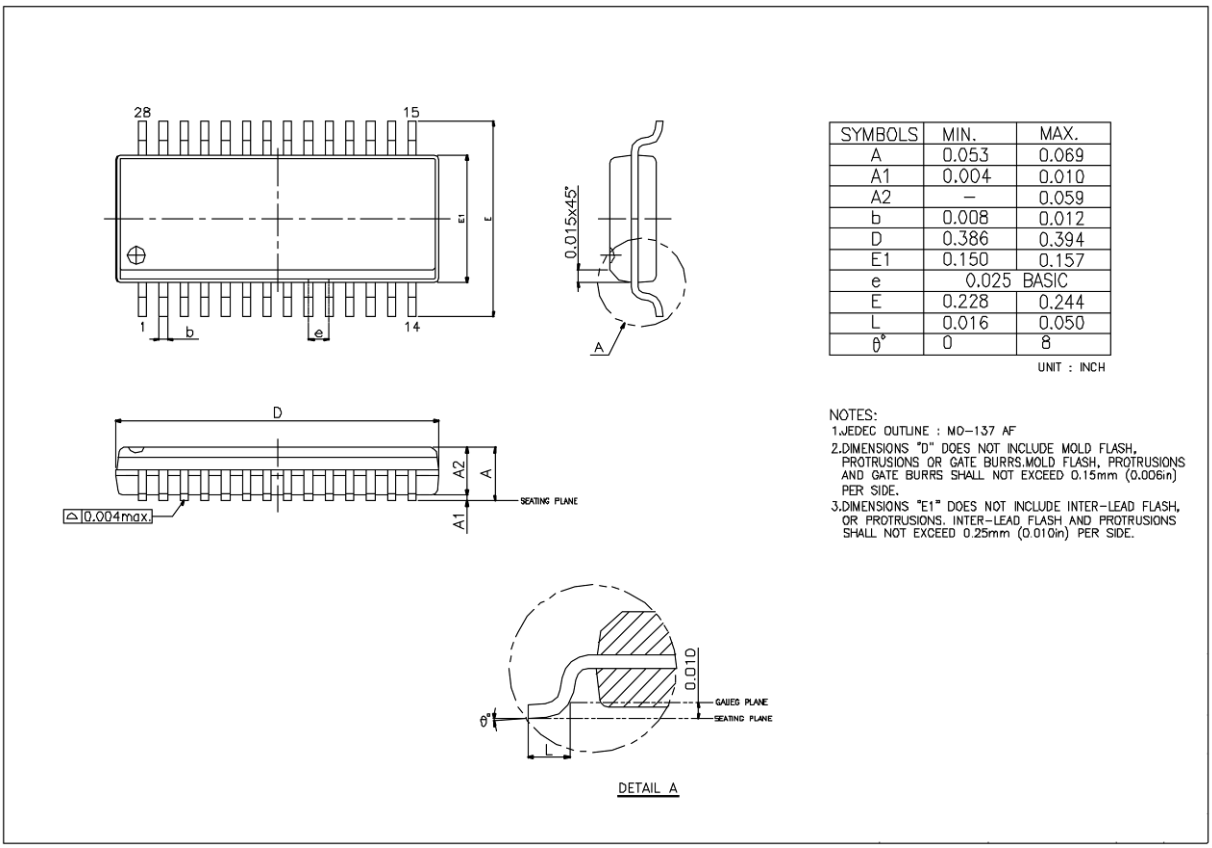
Package Outline



SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
A2	–	0.059
b	0.008	0.012
D	0.386	0.394
E1	0.150	0.157
e	0.025 BASIC	
E	0.228	0.244
L	0.016	0.050
θ°	0	8

UNIT : INCH

NOTES:
1.JEDEC OUTLINE : MO-137 AF
2.DIMENSIONS "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.15mm (0.006in) PER SIDE.
3.DIMENSIONS "E1" DOES NOT INCLUDE INTER-LEAD FLASH, OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.25mm (0.010in) PER SIDE.

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